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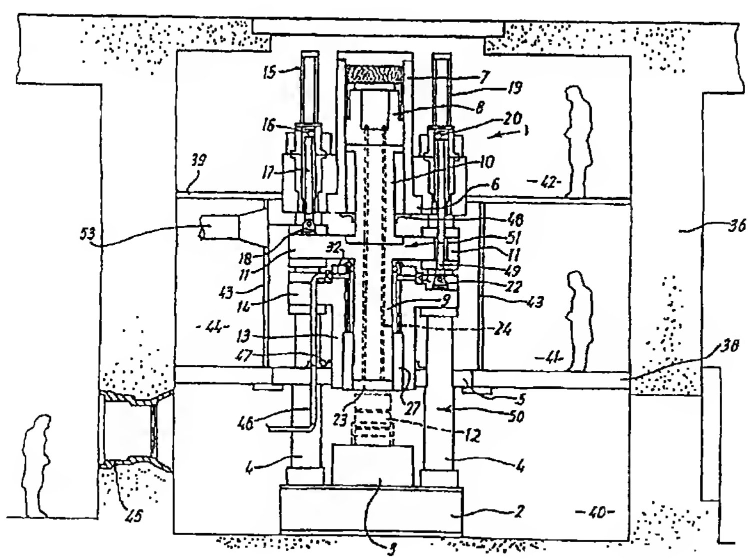

(57) Abstract

A compacter (1) for compacting containers containing radioactive waste (or toxic or other hazardous waste) comprises a mould (13) positioned around a container, resting on a press table (3), and a compacter ram (9) which is driven downwardly to compact the container. A mould liner (27) and a ram plate (23) are releasably secured to the mould and ram, respectively, by securing bolts (24, 29) which extend from the top of the mould and ram, respectively. In this way, ready access can be obtained to the bolt heads by operating personnel. In addition, there is no possibility of the bolt heads becoming clogged with debris and radioactive material because they are located remotely from the container (12) being compacted.

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COMPACTER FOR COMPACTING CONTAINERS CONTAINING HAZARDOUS WASTE

This invention relates to a compacter for compacting containers containing radioactive, toxic or other hazardous waste, in particular intermediate level radioactive waste. The description hereinbelow relates solely to drying radioactive waste, because that is the application for which the invention was developed. However, the compacter is equally applicable to compacting toxic, biologically dangerous or other hazardous waste, i.e. that is potentially harmful to humans or creatures on exposure to radiation from, or on contact with, such waste.

In the nuclear industry, spent nuclear fuel is reprocessed because most of its content, e.g. uranium and plutonium, are reusable. However, a proportion of radioactive waste is produced.

Radioactive waste divides into three categories, depending on the amount of radioactivity it contains - low, intermediate and high-level. Low level wastes are ones that typically need to be handled by personnel wearing protective clothing, but no physical barrier of substantial construction, e.g. concrete, is additionally required to shield operating personnel from radiation. High level waste, on the other hand, has a high enough radioactive content that it continues to generate heat, due to radioactive decay, in sufficient quantities that special cooling measures are needed

to prevent the temperature of the waste from rising to unacceptably high levels. Intermediate level waste has radioactivity levels between these two extremes. Solid radioactive wastes are in fact categorised in the UK as follows (Radioactive Waste Management Advisory committee 5th Annual Report June 1984):

High Level Waste (HLW)	:	significantly self heating wastes
Intermediate Level Waste	:	more than 4E9 Bq per te alpha or more than 12E9 Bq per te beta/gamma but not self heating.
Low Level Waste (LLW)	:	less than 4E9 Bq per te alpha and/or less than 12E9 Bq per te beta/gamma

Techniques are known for the long-term storage of radioactive waste. In the case of intermediate level and low level waste, storage is effected in a suitable structure, e.g. concrete encapsulation and concrete-lined vaults, respectively. Such storage structures have to be specially built so that they contain the radiation from the radioactive waste without risk of radiation leakage. This makes the storage of radioactive waste expensive and it would be desirable to reduce the cost.

It is known that low level radioactive waste can be dried to remove moisture, principally water, and then compacted under extremely large applied force, so that the volume occupied by the resulting waste product is less than that of the initial radioactive waste, in particular because all the

moisture has been removed and the internal voids distributed throughout the bulk of the material left behind as a result of the drying process are compressed flat as far as possible in the compaction process. This means that for any initial volume of low level waste, the size of the storage structure is minimised. The compaction process can be carried out using a compacter which comprises, essentially, a press table on which a (sacrificial) container containing low level radioactive waste is supported and a hydraulic press arrangement including a ram which is applied to the top end of the container under very high force. The compacter also comprises a mould that fits around the container with only a nominal clearance such that as the ram force is applied to the container from above, the mould prevents the container from distorting outwardly.

It will be appreciated that, in operation, the lower face of the ram, the inside surface of the mould and the top surface of the press plate are subjected to extremely high loads. Furthermore, the forces acting can be extreme in localised regions because the waste is typically not homogeneous, containing for example hard metal pieces, which makes the loading on the mould ram and press plate surfaces uneven.

Accordingly, after prolonged use, these surfaces can become physically damaged or worn and replacement is needed. Therefore, the mould can be fitted with an internal liner of hardened metal formed with a flange at its lower end which is bolted in a complementary recess in the underside of the mould. Similarly, a hardened metal plate may be

bolted to the bottom face of the main ram. Therefore, when the ram plate and liner need replacement, they merely have to be unbolted by maintenance personnel and replacement parts fitted. Similarly, the press table can have a removable press plate mounted on top of the press table, the press plate being replaced when it becomes worn or damaged.

With low level waste, these maintenance procedures can be carried out without undue difficulty, since it is sufficient for maintenance personnel to wear suitable protective clothing and to work directly in the zone where drum compaction is effected. However, the handling of intermediate level waste presents special difficulties, because all handling operations on such waste have to be performed in a sealed environment which maintenance personnel cannot enter since protective clothing is not adequate. Alternatively, hands-on maintenance is possible, but only after extensive decontamination and cleaning of the cell, which is time-consuming and costly, and therefore impractical.

There is therefore a need for a compacter for compacting radioactive waste, in particular intermediate level radioactive waste, in which the replaceable parts, in particular the ram plate and the mould liner, can be released without needing to gain access to the sealed hostile environment, in which the mould, bottom section of the ram and press plate are located.

According to the invention from one aspect there is provided a compacter for compacting containers containing radioactive, toxic or other

hazardous waste, comprising a press table for supporting a container to be compacted, a ram mounted above the press table and extending generally in an upwardly direction, hydraulic pressure means for urging the ram downwardly towards the press table to compact the container between the lower end of the ram and the press table and for withdrawing the ram from the container, and a mould that is positioned or positionable above and adjacent the press table for surrounding the container during compaction, the mould having a replaceable internal liner releasably secured in the mould by first securing means which is operable from the top of the mould for releasing the mould liner.

Because the first securing means is operable from the top of the mould, the mould liner can be released without the need for hands on maintenance in the radioactive zone where the container compaction takes place.

According to the invention from another aspect there is provided a compacter for compacting containers containing radioactive, toxic or other hazardous waste, comprising a press table for supporting a container to be compacted, a ram mounted above the press table and extending generally in an upward direction, the ram having a replaceable ram plate on the lower end thereof, said ram plate being releasably held in position by second securing means, which is operable from an upper region of the ram for releasing the ram plate, hydraulic pressure means for urging the ram towards the press table to compact the container between the lower end of the ram and the press table and for withdrawing the ram from the

container, and a mould that is positioned or positionable above and adjacent the press table for surrounding the container during compaction.

Because the second securing means is operable from an upper region (e.g the top end) of the ram, again the ram plate can be released by operating personnel without the need for hands on maintenance in the radioactive zone where the container compaction takes place.

In accordance with a preferred embodiment of the invention there is provided a compacter for compacting containers containing radioactive, toxic or other hazardous waste, comprising a press table for supporting a container to be compacted, a ram mounted above the press table and extending generally in an upward direction, the ram having a replaceable ram plate on the lower end thereof, said ram plate being releasably held in position by second securing means, which is operable from an upper region of the ram for releasing the ram plate, hydraulic pressure means for urging the ram towards the press table to compact the container between the lower end of the ram and the press table and for withdrawing the ram from the container, and a mould that is positioned or positionable above and adjacent the press table for surrounding the container during compaction, the mould having a replaceable internal liner releasably secured in the mould by first securing means which is operable from the top of the mould for releasing the mould liner.

Because the mould liner and the ram plate can be released from the top of the mould and an upper region, e.g. the top end, of the ram, respectively,

which, with the compacter installed in a waste handling plant having a sealed environment for the safe handling of the waste, would both be positioned outside the sealed environment in a safe handling area for operating personnel, the required maintenance can be performed without risk of operating personnel being exposed to harmful radiation.

Although various forms of respective securing means will be apparent to the skilled reader for use as the first and/or securing means, it is particularly preferred that these both comprise securing bolts.

In the case of the removable liner, these bolts pass through respective oversize holes extending through the mould from an upper end face thereof, the bolts being received in respective first screw-threaded bores in the liner. Conveniently, the liner can be a thick-walled cylindrical liner, the screw-threaded bores being formed in the upper end of the wall of the liner.

The liner may be held in the mould by a tapered interference fit which can be released by displacing the liner a short distance downwardly relative to the mould when the bolts are unscrewed from the liner. For effecting the release of the mould liner, removable washers, e.g. each comprising two C-shaped washer halves, are located between the underside of the bolt heads and the upper end face of the mould. Then, the bolts are slackened off slightly, the washers removed, the bolts retightened in the screwthreaded bores, the bolt heads then being spaced a short distance above the mould, and a part

of the ram used to apply downward pressure to displace the bolt heads into contact with the mould, thereby releasing the tapered interference fit.

In the case of the ram plate, the second securing means preferably comprises a plurality of bolts passing through a respective oversized holes extending through the ram from an upper face thereof to its underside, these bolts being received in respect second screw threaded bores formed in the ram plate.

Another disadvantage of previously considered bolting arrangements is that recesses, in which the bolt heads are received for protecting them from damage in the compacting process, become filled with debris and radioactive waste that has been squeezed from fractures in the container during compacting, which makes it difficult or impossible to gain access to the bolt heads for undoing them during maintenance. This problem is solved for the bolt heads of the bolts that are used according to the disclosure of the present specification, because, when the compacter is installed in the waste handling plant, the bolt heads are located outside the sealed hostile environment.

Once the mould liner and ram plate have been released in the radioactive environment, suitable transport means, e.g. a conveyor, robot and/or manipulators used for transferring containers of radioactive waste between the press plate and a remote decontamination and maintenance facility also located in the sealed environment, can also be used for removing the damaged mould liner and ram plate

from the location of the compacter and transporting replacement components to the compacter for being re-bolted in place.

According to a preferred embodiment, the hydraulic means comprises a single-acting, hydraulic ram cylinder and co-operating ram piston, one of which is connected to a plurality of upright support columns at or near an upper end thereof and the other of which is connected to said ram which is mounted generally parallel to the support columns and in a central location and is united with a cross-piece which is movably mounted on the support columns, so that hydraulic fluid supplied under pressure to said hydraulic cylinder causes said ram to move downwardly to compact the container against the press table, and at least two return hydraulic cylinders and respective co-operating pistons arranged on opposite sides of the ram cylinder, one of each return cylinder and co-operating piston being connected to said support columns at or near their upper ends and the other being connected to said cross-piece.

Because the return cylinders are laterally offset from the ram axis, if hydraulic fluid should leak from the return cylinders which, when the compacter is installed, are outside the sealed environment, the roof of the sealed environment can act as a physical barrier to prevent leaked hydraulic fluid entering into the sealed environment, which is particularly important since it is difficult to treat hydraulic fluid contaminated with radioactivity.

In a preferred embodiment, the ram hydraulic cylinder is mounted on, and extends above, a transverse structure interconnecting the upright support columns and the ram piston constitutes an upper part of the ram. The return hydraulic cylinders are mounted on, and extend above, the transverse structure and the return pistons are connected to the cross-piece. Additionally, the transverse structure is approximately square-shaped in plan view and the compacter has four support columns whose upper ends are respectively secured to the four corners of the transverse structure, the return hydraulic cylinders being mounted on the transverse structure, respectively at the mid-points of two opposite sides of the transverse structure.

This arrangement is especially compact and functional, and has the further advantage that, when the transverse structure is installed in an upper flooring which separates a second sealed environment, located above the roof of the first, radioactive, sealed environment, from a third environment for maintenance personnel, the second and first environments being held under increasingly reduced pressures relative to the pressure in the third environment, the ram and return hydraulic cylinders all extend into the third environment, so that maintenance can easily be carried out on these hydraulic cylinders.

In a preferred arrangement for the mould, it is carried on a cross-piece which is movably mounted on the support columns below the ram cross-piece, two double-acting hydraulic cylinders are mounted on, and extend above, said transverse structure, respectively

at the mid-points of the other two opposite sides of said transverse structure, and two pistons, respectively mounted in and co-operating with said double-acting hydraulic cylinders, are connected to said mould cross-piece for raising and lowering said mould.

Again this provides a compact construction and the double-acting cylinders are readily accessible from the working environment, and the mould is afforded stable guidance. Also, it is not normally possible for any hydraulic fluid that has leaked from the double acting cylinders to seep into the radioactive environment, in view of these cylinders being mounted to the side of the ram.

When installing the compacter, the press table is located in the sealed environment and the support columns extend upwardly through a further transverse structure interconnecting the support columns and forming part of the upper boundary of the sealed environment, the mould extending downwardly through an opening in the further transverse structure which carries a seal around said opening and sealing against the exterior of the mould. Even if any hydraulic fluid that has leaked from either double-acting cylinder has found its way down to the top surface of the further transverse structure where it is present as a few drops or a small pool, the leaked hydraulic fluid can reliably be prevented from entering the radioactive environment by the seal.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the

accompanying drawings, in which:-

Figure 1 is a vertical sectional view through a compacter installed in a protective cell that is horizontally divided to provide an upper working environment, an intermediate environment and a lower environment in which the drum compaction takes place,

Figure 2 is a vertical sectional view on an enlarged scale of the compacter of Figure 1, taken along the line II-II of Figure 4,

Figure 2A is an enlarged detail of part of Figure 1,

Figure 3 is a side elevational view of the compacter of Figure 2 as seen in the direction of arrow III in Figure 4, a double-acting cylinder/piston arrangement and its connection to a mould cross-piece being omitted for clarity, and

Figure 4 is a plan view of the compacter shown in Figure 2.

Referring to Figures 1 and 2, a compacter for intermediate level radioactive waste and designated generally by reference numeral 1 comprises a base structure 2 on which is mounted a press table 3 and, adjacent the four corners thereof in a symmetrical arrangement, four upright support columns 4, which are interconnected at a lower region by a first transverse structure 5 and at their top ends by a second transverse structure 6, the support columns 4 and the lower and upper transverse structures 5,6 together forming a rigid frame 50.

As best shown in Figures 2, 3 and 4, a ram cylinder 7 is mounted on the upper transverse structure 6 and extends upwardly from it. Mounted centrally within the frame 50 is a compaction ram 51 extending generally parallel to the upright supports 4 and comprising an upper ram piston 8, which is slidably mounted inside the ram cylinder 7, a connecting piece 10, and a main ram member 9 formed integrally with a cross-piece 11, which is slidably mounted on the four support columns 4. Hydraulic fluid admitted under pressure to the ram cylinder 7 urges the compaction ram 51 downwardly, the upright support columns 4 serving to guide the compaction ram 9 in a stable manner.

A cylindrical mould 13 is formed integrally with a cross-piece 14 which is also slidably mounted on the four upright support columns 4 for displacing the mould downwardly towards, and upwardly from, the press table 3 and which is positioned beneath the ram cross-piece 11. The function of the cylindrical mould 13 is to prevent radial distortion of the cylindrical container when the ram is applied under pressure to the container 12, the mould, when fitted around the container 12, leaving only a nominal clearance between them. Figures 1 to 3 show the compaction ram 51 and the mould 13 in their fully raised positions in which adequate clearance is provided for a cylindrical container 12 (typical capacity 45 gallons) of intermediate level radioactive waste to be positioned, by suitable means (not shown) such as a remotely operated transfer device, at a predetermined central position on top of the press table 3.

Referring to Figures 2 to 4, the upper transverse structure 6 is approximately square-shaped in plan view (Figure 4) and is secured to the four support columns 4 at its four corners. Two ram return cylinders 15 are mounted at the mid-points of two opposite sides of the transverse structure 6 and project upwardly therefrom. Ram pistons 16, respectively mounted in the hydraulic cylinders 15, are connected by connecting rods 17 to the ram cross-piece 11, the cross-pieces carrying trunnions 18 which provide pivotal connections between the lower ends of the connecting rods 17 and the ram cross piece 11, so as to accommodate small changes in the relative orientations of the connecting rods and the ram cross-piece when the ram is lowered and raised. When hydraulic fluid is admitted under pressure to the hydraulic cylinders 15, the pistons 16 are urged upwardly to effect the return stroke of the ram 9 to its raised position. Although the return cylinders 15 need only be single-acting, it is preferred that they be double-acting, in order that the cross-piece 21 can be raised and lowered when the ram cylinder 7 and its ram piston 8 are taken out of service for maintenance.

Similarly, two double-acting hydraulic cylinders 19 are mounted at the mid-points of the other pair of opposite sides of the upper transverse structure 6 and project upwardly from the transverse structure. A piston 20 disposed in each double-acting hydraulic cylinder 19 is connected by a connecting rod 49, which passes freely through an oversize bore 21 in ram cross-piece 11, to mould cross-piece 14, a trunnion 22 providing a pivotal connection between the lower end of connecting rod 49

and mould cross-piece 14 to accommodate small changes in the relative orientations of the connecting rod 49 and mould cross-piece 14 as the mould 13 is urged up and down the support columns 4 by the action of the double-acting piston/cylinder arrangement 19, 20.

Referring to Figure 2A in particular, the lower end of the ram member 9 is fitted with a replaceable ram plate 23 of hardened steel, designed to withstand as far as possible the very high loading and localised pressure points resulting when the container is being compacted. Locating means, e.g. locating lugs received in correspondingly shaped bores formed in the underside of the ram member 9, serve to locate the ram plate correctly with respect to the ram member 9. In order to secure the ram plate in position, a plurality of bolts 24, for example four bolts, extend through registering holes or passageways formed in the ram piston 8, ram connecting piece 10 and ram member 9 and are received in complementary screw-threaded bores 55 formed in the top face of the ram plate 23. The bolt heads are tightened against the bottom end surface of an axial blind passage 25 formed centrally from the top face of the ram piston 8 and extending close to the bottom of the ram piston. In this way, the ram plate 23 is releasably secured to the bottom end of the ram 9.

This securing arrangement for the ram plate 23 is especially advantageous in that it provides ready access to the bolt heads from the top of the compacter, merely by removing a removable top cover 26 from the ram cylinder. In this way, when the ram plate becomes worn, it can be released from the ram 9 without entering the radioactive environment in which

the container is compacted. Furthermore, access to the bolt heads through the open upper end of the ram cylinder 7 is from a working environment for operating personnel as will be described below in more detail. Another advantage is that the bolt heads cannot become clogged with debris and radioactive waste in view of their distancing from the compaction region. The released ram plate falls into the radioactive environment and is taken by for example a conveyor system and/or remote manipulators to a decontamination and maintenance facility. A replacement ram plate is supplied and fitting by essentially the reverse process and is not further described herein.

In view of the considerable loading, both general and localised, that can be exerted on the inner surface of the mould 13 by the container 12 during compaction, the mould is provided on this inner surface with a liner 27, again of hardened steel. The liner is preferably of single-part construction and is received in a complementary recess formed in the lower section of the mould. As shown in Figure 2, the height of the mould liner is substantially the same as that of the container.

It will be appreciated that since the function of the liner is to protect the body of the mould from damage while the function of the mould body is to withstand the stresses exerted on the mould when the drum is compacted by the ram, the mould liner needs to be an interference fit within the mould so that it can transmit stresses to the mould without itself being distorted. To facilitate engagement of the liner 27 with the mould 13 and also removal of the

mould liner from the mould, the liner is preferably a taper-fit, so that it can be freely inserted into the mould from below (when the mould is in its raised position) until it becomes an interference fit within the mould body as it approaches its final location within the mould and so that the interference fit is released after the liner has been displaced only a short distance downwardly.

As best shown in Figure 2A, the liner is removably secured in place by a plurality of bolts 29 that extend through oversize axial bores 30 formed through the height of the mould and are received in corresponding screw-threaded bores 54 formed in the wall of liner 27. Consequently, the liner wall thickness needs to be sufficient to accommodate the lower ends of the bolts 29. To ensure the liner is located in the correct angular orientation, locating dowels or the like can be used.

Beneath each bolt head is a split washer 28, in the form of two C-shaped elements (not shown) butted one against the other. When a damaged liner needs to be replaced, the bolts 29 are slackened off slightly so that the split washers can be removed and then the bolts are tightened again until their ends abut with the ends of the bores 54 formed in the mould liner. The lengths of these screwthreaded bores and the bolts are such that the bolt heads are spaced above the top surface of the mould by a short distance. Then, the two (C-shaped) halves of a shim (not shown) are fitted around the central ram member 9 and rest on the protruding bolt heads. By applying hydraulic pressure to the ram cylinder 26 while holding the mould in its raised position, the ram

moves downwardly, the ram cross-piece 11 pressing against the top surface of the shim and, in turn urging the mould liner downwardly too. The spacing between the bolt heads and mould is sufficient that before the bolt heads have been forced back into contact with the top surface of the mould, the taper interference fit between the liner and mould will have been released. Then, by raising the ram to its uppermost position again and lowering the mould until the liner sits on the press table 3, access can be had to the bolt heads, so that the bolts 29 can be unscrewed and removed, so as to release the mould liner from the mould. After the mould has been raised again to its uppermost position, the separated liner can be transported to a remote decontamination and maintenance facility for handling in ways which are well known in the art and which therefore do not need to be described in any detail.

Insertion of a replacement liner is essentially a reversal of the dismantling process, and involves transporting the replacement liner to the compacter and raising it into position inside the mould, using a combination of conveyor systems or the like and remote controlled manipulators. Locating means, such as the locating dowels mentioned above are preferably used to locate the mould liner in the correct angular orientation. Then, replacement bolts 29 are inserted and tightened up to secure the replacement liner in position in the mould.

Referring to the detailed view of Figure 2A, an annular space 52 exists between the inner face of the mould and the outside of the ram member 9. An annular seal 31 carried by the mould seals against

the outside surface of ram member 9. An annular clearance 53 of smaller width than that of annular space 52, is provided between the ram member 9 and the surrounding mould liner 27. There is also an even narrower clearance between the ram plate 23 and the mould liner. An air inlet line 35, including a non-return valve 34 and filter (not shown), communicates with an annular space 52 just below the seal 31 while an air exhaust line 32, also communicating with the space 52 just below the seal 31, includes a non-return valve 33 and filter (not shown) and passes down through the lower transverse structure 5 and terminates in the environment in which compaction takes place. The upward and downward movement of the mould is accommodated by a telescopic-type, sliding connection 46 in the exhaust line 32.

For compacting a container, firstly the mould is lowered around the container until its lower end contacts the press table 3. As the mould is lowered, a small quantity of air is exhausted through exhaust line 32 due to the relative movement between the mould and the ram plate 23. Then the ram is driven downwardly inside the mould, compacting the drum to form a so-called puck and causing air in the mould to be compressed and pass upwardly through the annular space 52 and out through exhaust line 32. Since drums can fracture during compaction and since the space within the mould is filled with air from the radioactive environment in which the compaction is carried out before the ram is lowered, the expelled air contains radioactive contamination which is removed by the filter in air exhaust line 32.

After container compaction is completed, the compacter ram is held in its lower position while the mould is raised clear of the top of the puck. This guarantees the separation of the mould from the puck, which can get very tightly lodged in the mould during compaction. During raising the mould, non-return valve 33 shuts and non-return valve 34 opens to admit a small quantity of air into the annular space 52. Finally, the ram is raised to its raised position and the puck is removed, for example by a conveyor system and/or automatic manipulators (which can also be used for removing and replacing worn mould liners and ram plates, periodically). Then the next container to be compacted is brought to the press table 3 and the cycle repeated.

Referring now to Figure 1, the compacter is installed in a protective, thick-walled (e.g. 1.2m thick), concrete cell 36. The interior space within the protective cell is horizontally sub-divided by lower flooring 38 and upper flooring 39 to provide a first environment 40 in which compaction takes place and to which operating personnel are not admitted due to the radioactivity of the waste, a second environment 41, to which operating personnel can have access providing appropriate protective measures are taken (e.g. the wearing of suitable protective clothing) and an upper environment 42 for maintenance of the hydraulic equipment, this environment requiring a lower level of protection for operating personnel. Furthermore, the middle environment 41 is vertically segregated by vertical walls 43 on all four sides of the compacter to define a fourth environment 44.

The flooring 38 is made of concrete and contains the radiation from the radioactive waste within the bottom environment 40. The function of the upper flooring 39 and the vertical walls 43, however, is not to provide this shielding function because the radiation from the waste is absorbed by the concrete walls and floor of the cell and the concrete flooring 38. Rather, the upper flooring 39 and the vertical walls 43 serve to segregate and define different environments 41, 42, 44 which are used to control the spread of radioactive contamination, which is present in successively smaller quantities in environments 44, 42 and 41, respectively. In particular, in a manner known per se, cascaded pressures are maintained in the three environments such that the pressure successively increases from the upper environment through the intermediate environment to the lower environment. For example, the bottom environment 40 would be held at an atmospheric depression of say 200 Pa with respect to the middle environment 41, which itself is held at a similar depression to the top environment 42. In this way, if there should be any fault which could give rise to air leakage from one environment to another, then the flow direction will always be into an environment of potentially higher level of radioactive contamination. A suction path for maintaining reduced pressure in the environment 44 is shown at 53.

In order to seal the environments 40,41 and 42 from one another, the lower transverse structure 5 is designed to form a section of the lower flooring 38, to which it is connected in fluid-tight manner. Similarly, the upper transverse structure 6 forms a

section of the upper flooring 39 and is connected to it in fluid-type manner. A lip seal 47 on the lower transverse structure 5 seals against the outside of the mould and another lip seal 48, carried on the underside of the upper transverse structure 6 seals against the outside of the ram connecting piece 10.

Inspection windows, such as shown at 45, formed in the cell wall enable operating personnel to view operations taking place within the radioactive, bottom, environment 40, without danger of personnel being exposed to harmful radiation.

According to a modification (not shown), instead of using bolts 24, as described above, for securing the ram plate 23 in position on the bottom face of the ram 51, the ram plate may be held in position by a securing rod extending in a central axial bore in the ram member 9, the rod being connected at its lower end to the ram plate by a bayonet connection and bolted, by means of a flange at its upper end, to the ram member 9 (or alternatively held in position by removable locating dowels). Relative annular displacement between the ram member 9 and ram plate 23 is prevented by dowel pins. To release the ram plate, the ram connecting piece 10 is removed from the compacter, the securing rod flange released from the ram member 9 and turned from the top to release the bayonet connection, and, if need be, the rod pushed down against the ram plate to disengage the dowel pins locating the ram plate relative to the ram member.

The disclosed compacter is particularly advantageous in that the replaceable mould liner and ram plate can both be released when they are to be replaced, by untightening the respective two sets of securing bolts, whose bolt heads are accessible from the top of the mould and the top of the ram, respectively. Furthermore, there is no risk of the bolt heads becoming clogged with debris and radioactive material, in view of their remote location from the location of the drum.

Another advantage is that there is effectively no real risk of hydraulic fluid that has leaked from any of the hydraulic cylinders running down into the radioactive environment 40, which would be highly undesirable and result in effluent disposal problems. In the case of ram cylinder 7, hydraulic pressure is exerted only on the upper face of piston 8 and any leakage down the outside of the ram cylinder will be contained by the flooring 38 and the transverse structure 6. In the case of the ram return cylinders 15 and the double-acting cylinders 19, any hydraulic fluid, applied to the underside of the respective pistons to effect the upward stroke, that has leaked out of the cylinders would nevertheless be contained within the environment 44 by the lower transverse structure 5, the lip seal 47 guaranteeing that any hydraulic fluid on the upper surface of transverse structure 5 cannot pass into the radioactive environment 40. By these measures, hydraulic fluid is prevented from reaching containers in the compacter awaiting compaction or compacted containers (pucks), which may still be hot from the preceding dryer if they were not cooled before loading into the compacter.

Another advantage of the disclosed compacter is that even though the compacter ram has to have a significant length since it extends from the upper environment 42 down to the radioactive environment 40, the slidable mounting of the ram cross-piece on the four support columns ensures that, despite its length, the ram is stably guided throughout its downward and upward strokes. This is important, in order to minimise wear on the lip seal 48. Similarly, the mould is also guided in a stable manner by the support columns 4, which minimises wear on the lip seals 47.

It is also advantageous that most routine maintenance procedures can be carried out without the need to gain acess to the hostile environment 40 in which the container compaction takes place.

Reference is made to our co-pending UK patent application No. (agents reference P11234) which discloses a process and apparatus for treating radioactive, toxic or other hazardous waste involving drying the waste followed by compacting it in a compacter according to the present disclosure. Reference is also made to our co-pending UK patent application No. (agents reference P11248) which discloses the present compacter but claims a different inventive aspect thereof.

CLAIMS:

1. A compacter for compacting containers containing radioactive, toxic or other hazardous waste, comprising:

a press table for supporting a container to be compacted,

a ram mounted above the press table and extending generally in an upward direction,

hydraulic pressure means for urging the ram downwardly towards the press table to compact the container between the lower end of the ram and the press table and for withdrawing the ram from the container, and

a mould that is positioned or positionable above and adjacent the press table for surrounding the container during compaction, the mould having a replaceable internal liner releasably secured in the mould by first securing means which is operable from the top of the mould for releasing the mould liner.

2. A compacter for compacting containers containing radioactive, toxic or other hazardous waste, comprising:

a press table for supporting a container to be compacted,

a ram mounted above the press table and extending generally in an upward direction, the ram having a replaceable ram plate on the lower end thereof, said ram plate being releasably held in position by second securing means which is operable from an upper region of the ram for releasing the ram plate,

hydraulic pressure means for urging the ram towards the press table to compact the container

between the lower end of the ram and the press table and for withdrawing the ram from the container, and

a mould that is positioned or positionable above and adjacent the press table for surrounding the container during compaction.

3. A compacter for compacting containers containing radioactive, toxic or other hazardous waste, comprising:

a press table for supporting a container to be compacted,

a ram mounted above the press table and extending generally in an upward direction, the ram having a replaceable ram plate on the lower end thereof, said ram plate being releasably held in position by second securing means, which is operable from an upper region of the ram for releasing the ram plate,

hydraulic pressure means for urging the ram towards the press table to compact the container between the lower end of the ram and the press table and for withdrawing the ram from the drum, and

a mould that is positioned or positionable above and adjacent the press table for surrounding the container during compaction, the mould having a replaceable internal liner releasably secured in the mould by first securing means which is operable from the top of the mould for releasing the mould liner.

4. A compacter according to claim 1 or 3, wherein said first securing means comprises a plurality of first bolts passing through respective oversize holes extending through the mould from an upper end face thereof, said first bolts being received in respective first screwthreaded bores in the liner.

5. A compacter according to claim 4, wherein said first screwthreaded bores are formed in the upper end of the wall of the liner.

6. A compacter according to claim 4 or 5, wherein said liner is held in said mould by a tapered interference fit which can be released by displacing the liner a short distance downwardly relative to the mould when said bolts are unscrewed from the liner, and wherein removable washers are located between the underside of the bolt heads and the upper end face of the mould, so that by slackening off the bolts slightly, removing the washers, retightening the bolts in said screwthreaded bores, the bolt heads then being spaced a short distance above the mould, and using a part of the ram to apply downward pressure to displace the bolt heads into contact with the mould, the tapered interference fit between the liner and the mould is released.

7. A compacter according to claim 2 or 3 or claim 4, 5 or 6 as appended to claim 3, wherein said second securing means comprises a plurality of second bolts passing through respective oversize holes extending through the ram from an upper face thereof to its underside, said second bolts being received in respective second screwthreaded bores formed in the ram plate.

8. A compacter according to any preceding claim, wherein the hydraulic pressure means comprises:

a single-acting, hydraulic ram cylinder and co-operating ram piston, one of which is connected to a plurality of upright support columns at or near an upper end thereof and the other of which is connected to said ram which is mounted generally parallel to the support columns and in a central location and is united with a cross-piece which is movably mounted on the support columns, so that hydraulic fluid supplied under pressure to said hydraulic cylinder causes said ram to move downwardly to compact the container against the press table, and

at least two return hydraulic cylinders and respective co-operating pistons, arranged on opposite sides of the ram cylinder, one of each return cylinder and co-operating piston being connected to said support columns at or near their upper ends and the other being connected to said cross-piece.

9. A compacter as claimed in claim 8, wherein said ram hydraulic cylinder is mounted on, and extends above, a transverse structure interconnecting said upright support columns and said ram piston constitutes an upper part of said ram, wherein said return hydraulic cylinders are mounted on, and extend above, said transverse structure and said return pistons are connected to said cross-piece, and wherein said transverse structure is approximately square-shaped in plan view and the compacter has four support columns whose upper ends are respectively secured to the four corners of the transverse structure, the return hydraulic cylinders being mounted on said transverse structure, respectively at the mid-points of two opposite sides of said transverse structure.

10. A compacter according to claim 9, wherein the mould is carried on a cross-piece which is movably mounted on the support columns below the ram cross-piece, two double-acting hydraulic cylinders are mounted on, and extend above, said transverse structure, respectively at the mid-points of the other two opposite sides of said transverse structure, and two pistons, respectively mounted in and co-operating with said double-acting hydraulic cylinders, are connected to said mould cross-piece for raising and lowering said mould.

11. A compacter according to claim 9 or 10, further comprising a first sealed environment in which the container is to be compacted, the press table being disposed in said sealed environment and said support columns extending upwardly through a further transverse structure interconnecting the support columns and forming part of the upper boundary of said sealed environment, said mould extending downwardly through an opening in said further transverse structure which carries a seal around said opening and sealing against the exterior of the mould.

12. A compacter according to claim 11, wherein the first mentioned transverse structure is connected, in fluid-tight manner, in an upper flooring which separates a second sealed environment located above said first sealed environment from a third environment, said ram, return and mould cylinders all extending upwardly from said transverse structure into said third environment, means being provided for maintaining said second and first environments under increasingly reduced pressures relative to the pressure in said third environment.

13. A compacter for compacting containers containing radioactive, toxic or other hazardous waste, substantially as hereinbefore described with reference to the accompanying drawings.

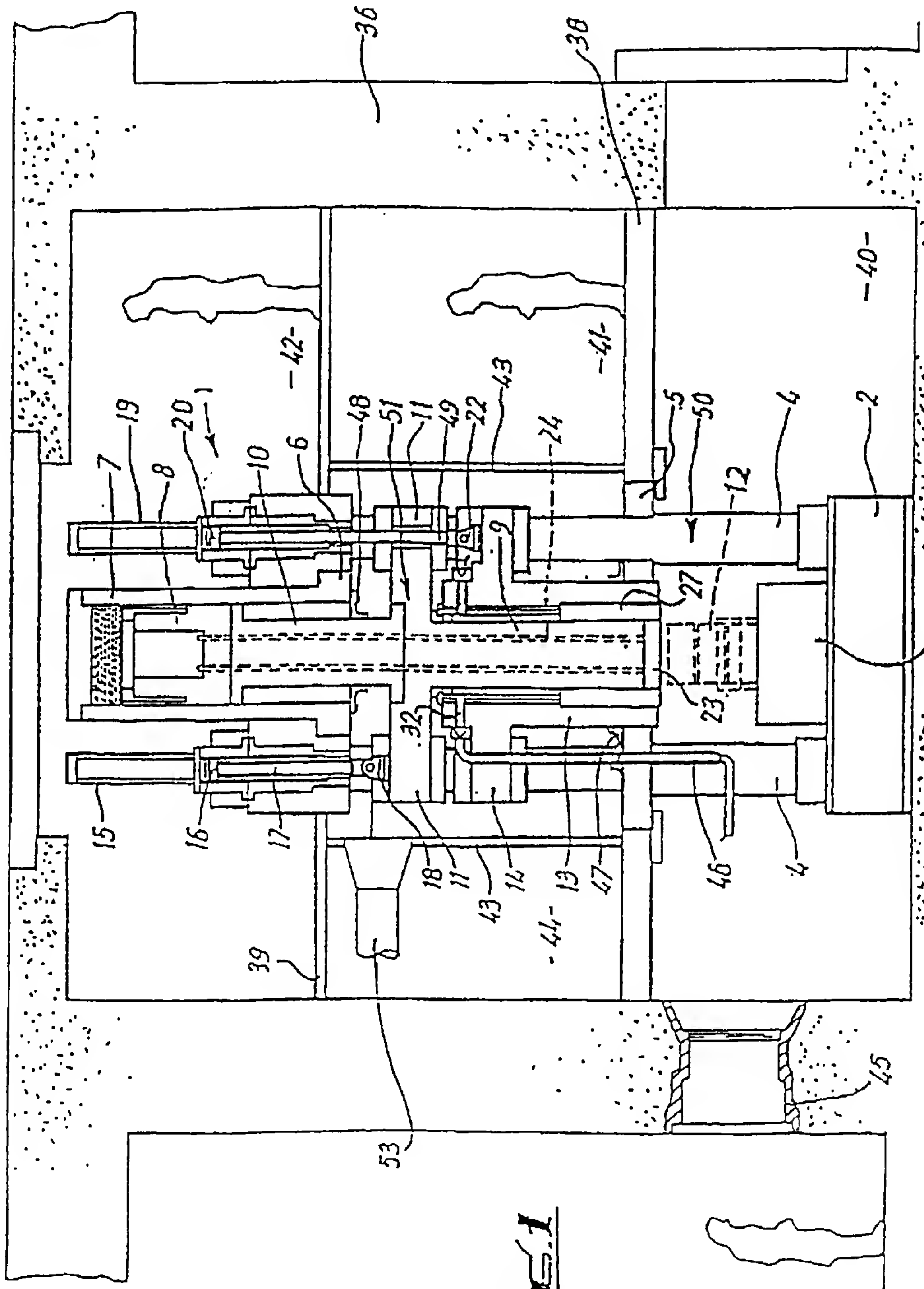
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Fig.1

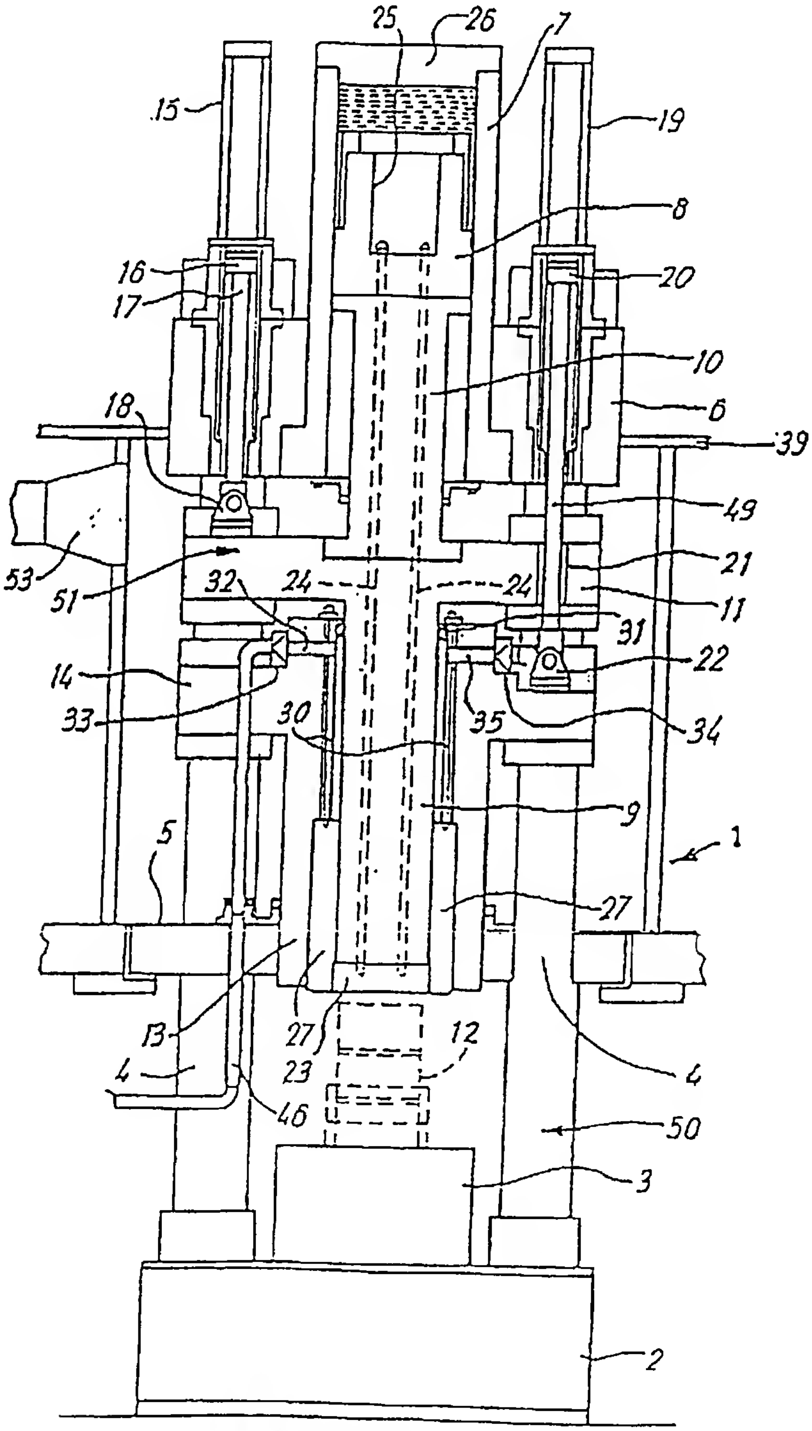
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FIG. 2

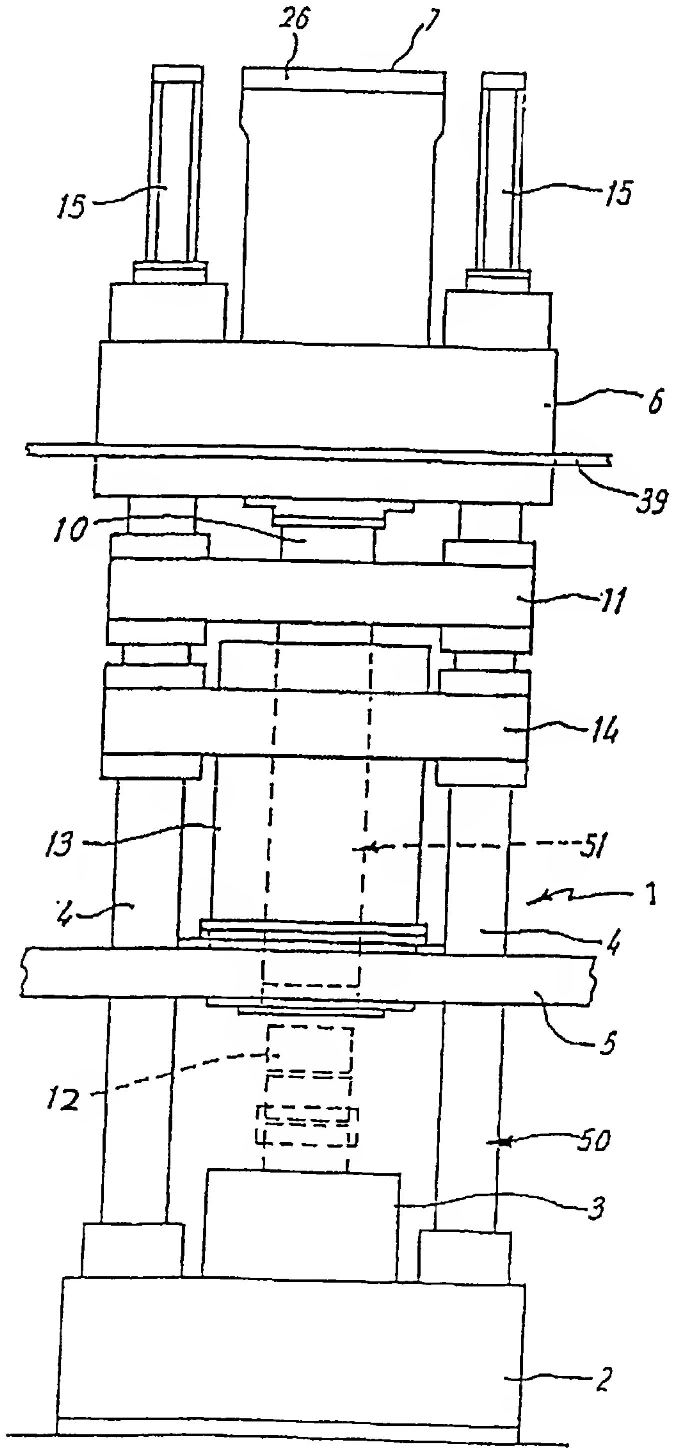

FIG. 3

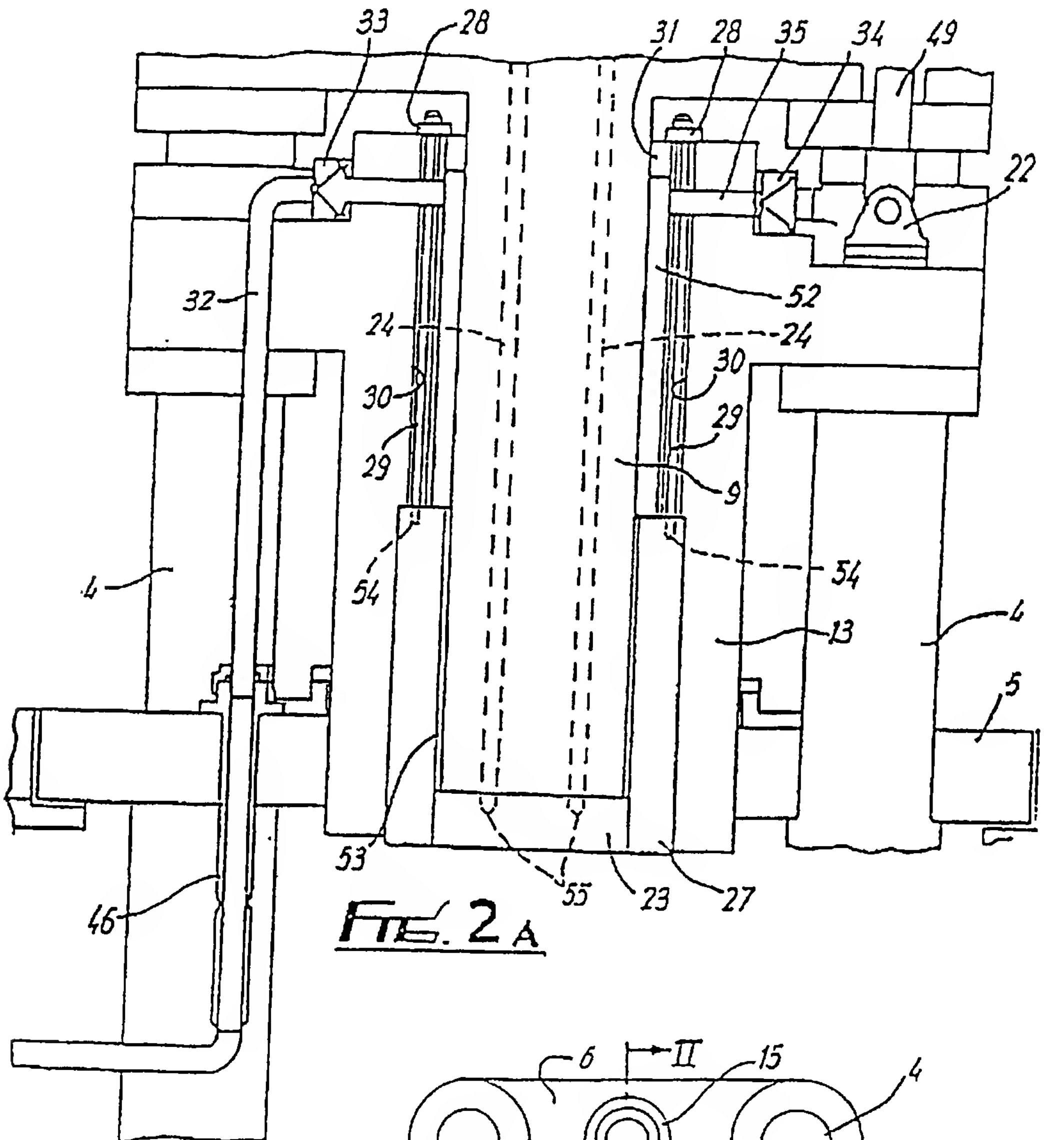
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FIG. 2A

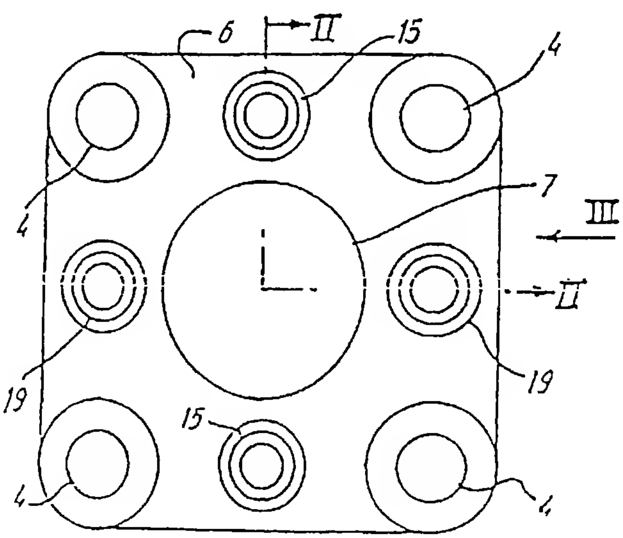
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FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 95/03922

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G21F9/36 G21F9/34 B30B9/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G21F B30B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP,A,0 124 185 (MACHINEFABRIEK A. FONTEIIJNE) 7 November 1984 see abstract; claims 1-3; figure 1 ---	1-13
Y	EP,A,0 555 131 (ACB) 11 August 1993 see abstract; claims 1-4; figures 1,2 ---	1-13
Y	EP,A,0 178 802 (NGK INSULATORS) 23 April 1986 see abstract; claims 1-8; figures 1,3 ---	1-13
Y	EP,A,0 202 605 (ALSTHOM) 26 November 1986 see abstract; claims 1-3; figure ---	1-13
A	DE,A,26 59 691 (KERNFORSCHUNGSZENTRUM KARLSRUHE) 16 November 1978 see claims 1-6; figures 1,2 -----	1-13

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

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Date of the actual completion of the international search	Date of mailing of the international search report
12 June 1996	24.06.96
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Authorized officer Nicolas, H

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 95/03922

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